

Effect of Anthropometric, Socioeconomic, and Behavioral Factors on Early Childhood Dental Caries in Tehran: A Structural Equations Modeling Approach

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Abstract

Background and Aim: Identification of the factors that affect early dental caries has an important role in health planning in different societies. This study was conducted to evaluate the effect of different factors on early caries in deciduous teeth.

Materials and Methods: This cross-sectional study was conducted on 603 children aged 3-5 years in Tehran during 2013-14. Multistage stratified random sampling was done in the northern, southern, eastern, and western regions of Tehran. Data were collected by dental examination and by using a questionnaire answered by the parents. The Poisson regression analysis was used for evaluating the correlation between the independent variables and the results, while the structural equation modeling (SEM) method was applied to evaluate the joint effect of these factors on dental caries indices.

Results: The mean and standard deviation (SD) of the decayed-missing-filled-teeth (dmft) and decayed-missing-filled-surfaces (dmfs) were equal to 6.45 ± 4.02 and 11.62 ± 10.61 , respectively. The effects of body mass index (BMI) and the latent variables of poor eating habits and oral hygiene on the dmft and dmfs were significant ($P < 0.05$). The effect of the household socioeconomic status, as a latent variable, on the caries indices was not significant ($P = 0.29$). Among the variables, poor eating habits had the greatest effect on the dmft (total standardized value = 0.31) and dmfs (total standardized value = 0.33).

Conclusion: Dental caries is associated with poor eating habits, oral hygiene, and BMI. These factors can be modified and corrected through public health approaches such as providing counseling services, defining the principles of health behaviors, and teaching proper eating habits to parents and children.

Key Words: Dental Caries, Children, Deciduous Teeth, Iran

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Introduction

Dental caries is one of the most prevalent diseases in humans and affects almost everybody during their lifetime [1]. Early childhood caries (ECC) is a serious public health problem in the developing and developed countries [2,3]. ECC is a major

cause of hospitalization of children [4], and it is a costly health problem [5]. ECC can cause pain, infection, and an increased risk of caries in permanent teeth [6]. Also, the absence of a timely action to prevent and control ECC would cause serious side effects and complications and may

even lead to death [7].

Although the growth of deciduous tooth decay is fairly controlled in the developed countries and its incidence is descending [8], the evidence suggests that this problem is following an ascending trend in the developing countries, including Iran [9,10]. The frequency of ECC in Iran is extremely high in comparison with the frequency in the developed countries and compared to the standards of the World Health Organization (WHO); therefore, special attention should be paid in order to control childhood dental caries [11].

Dental caries is a multifactorial disease [12], and the first step for caries control and prevention would be the identification of the influential risk factors. Many studies have been performed in Iran and throughout the world to investigate the determinants of ECC [12-15]. Nevertheless, in most studies, the impact of different causes of tooth decay has been studied by using simple statistical methods [16]. However, due to the multifactorial nature of tooth decay, the influential factors should be evaluated by utilizing multivariate statistical analyses. Therefore, structural equation modeling (SEM) was used in this study. Simultaneous calculation of the direct and indirect effects of the risk factors on dental caries is one of the most important advantages of this statistical analytical method [17-19].

Accordingly, the aim of this study was to simultaneously investigate the direct and indirect correlation between several demographic, anthropometric, clinical, and public health factors and dental caries by analyzing the multivariate structural equation.

Materials and Methods

This study was conducted by using the data collected from a random sample of children aged 3-5 years selected by multistage stratified random sampling in Tehran during 2013-14. This study has been approved by the Vice Chancellor of Research of Tehran University of Medical Sciences (project no. 9311105006) and by the Ethics Committee of Tehran University of Medical Sciences (IR.TUMS.SPH.REC.1396.4310). Twenty-nine kindergartens were selected by probability proportional to size sampling from the northern, southern, eastern, and western regions of Tehran.

On average, 20 children were selected from each kindergarten. The inclusion criteria consisted of being 3 to 5 years old, being a resident of Tehran city, and having health records. Dental carious lesions were assessed by three professional dentists.

Finally, after obtaining the approval of the authorities of the State Welfare Organization of Iran and the kindergartens, verbal consents were received from the parents, and the data of 603 children were collected.

The data were collected by using questionnaires and through interviews, measurements, and dental examinations. At the first step, demographic data including age and sex, anthropometric indices including height, weight, and head circumference, the educational level of the parents, household income, and children's dietary and oral health habits were collected through questionnaires completed by the parents and also by checking the vaccination cards of the participants. During the second phase, all the children were examined for dental caries. During this phase, the numbers of the decayed, missing, and filled teeth (dmft) and also decayed, missing and filled surfaces (dmfs) were counted. Finally, the dmft and dmfs indices were measured in order to investigate the status of dental caries and to check the status of each dental surface, respectively. The carious lesions were detected by visual examination. In this study, a tooth has been considered carious only in case of dentin involvement. Finally, there were no missing data in the selected sample.

Statistical analysis:

The first part demonstrates the statistical analysis of the descriptive data related to the participants. Given the multifactorial nature of tooth decay, the SEM multivariate analysis was used to identify the determinants of dental caries. The SEM is a way to evaluate causal relationships, to analyze different variables in a theory-based structure, and to demonstrate the overall impact of the variables [20]. This modeling consists of a regression equation device that is simultaneously fitted to the data [21]. In this method, the hypothetical relationship between the observed and latent variables is discussed through direct and indirect correlations. This model allows for the assessment of the relationship between the observed and latent

variables, the estimation of the error of the analysis of the observed and latent variables, the modification of the model, and the selection of the most appropriate model [22]. The SEM is based on minimizing the difference between the sample covariance matrix and the covariance matrix obtained by the theoretical model [22]. The minimization is done by the use of the weighted maximum likelihood (WML) method, and the goal is to determine the extent to which the theoretical models are supported by the sample data [23]. The Goodness-of-Fit Index (GFI), Adjusted Goodness-of-Fit Index (AGFI), Comparative Fit Index (CFI), Chi-square (χ^2), and Root Mean Square Error of Approximation (RMSEA) were used to evaluate the fitting of these models. The ideal values of these indices are defined as AGFI>0.9, GFI>0.9,

$$CFI > 0.9, \frac{\chi^2}{df \text{ (degrees of freedom)}} < 3 \text{ and}$$

RMSEA<0.8 [23]. To enter the independent variables into the model, the correlation of each independent variable with the response variables was measured. For this purpose, due to the countable nature of the response variables of the dmft and dmfs, the Poisson regression model was used for univariate analysis, and the variables that were significantly associated with the answers were included in the final model (the Poisson regression results are not shown in this article).

Eventually, the variables were selected to be entered in the final SEM based on the results of the literature review, dental consultation, and the comments of an expert statistician, and the following theoretical model (Figure 1) was hypothetically designed.

In the proposed model, the oval represents the latent variable that is not directly measurable, and the rectangle represents the observed variable that is directly measurable. "e" represents the error value for the observed variables, and "d" shows the error value for the latent variables. Statistical analyses were performed by using SPSS version 16 (IBM Co., Chicago, IL, USA) and Amos version 6 (IBM Co., Chicago, IL, USA) software programs.

Results

Table 1 demonstrates the basic information related

to the participants. 58% of the participants were boys. More than 70% of the parents (mothers) had a bachelor's degree or a higher level of education (Table 1). On average, the number of the decayed, missed, and filled teeth was equal to 6.45 per person. Also, the mean number of the decayed, missed, and filled dental surfaces was equal to 11.62 per person (Table 2).

The results of SEM:

In the final model, the effects of body mass index (BMI), as an observed variable, and poor eating habits, socioeconomic status of family, and oral hygiene, as three latent variables, were evaluated on the dmft (Figure 2) and dmfs (Figure 3). The WML estimations of the factor loadings, p-values, and goodness-of-fit indices of the models are demonstrated in Figures 2 and 3. The tables related to these figures show the direct, indirect, and overall effects of the studied factors on the dmft (Table 3) and dmfs (Table 4). The overall effect of each factor on the response was obtained by summing up its direct and indirect effects.

According to the results of the two models, the associations between dental caries and BMI, as an observed variable, with an overall effect of -0.11 on the dmft and -0.10 on the dmfs, and oral hygiene, as a latent variable, with an overall effect of -0.20 on the dmft and -0.15 on the dmfs, were significant and negative (Tables 3 and 4). Furthermore, poor eating habits, with an overall effect of 0.29 on the dmft and 0.32 on the dmfs, had a significant positive relationship with dental caries, while the household socioeconomic status, with an overall effect of -0.09 on the dmft and -0.11 on the dmfs, had a nonsignificant negative correlation with dental caries (Tables 3 and 4). Moreover, the two latent variables had a significant indirect correlation with dental caries. These variables included poor eating habits with an indirect effect of -0.01 on the dmft (Table 3) and -0.01 on the dmfs (Table 4), and the household socioeconomic status with an indirect effect of -0.15 on the dmft and -0.14 on the dmfs.

The intensity of the effect of the factors on the responses was shown by the absolute value of the regression coefficients of the two models. Poor eating habits, with a coefficient of 0.31 in the first model (Figure 2) and 0.33 in the second model (Figure 3), had the greatest effect on dental caries

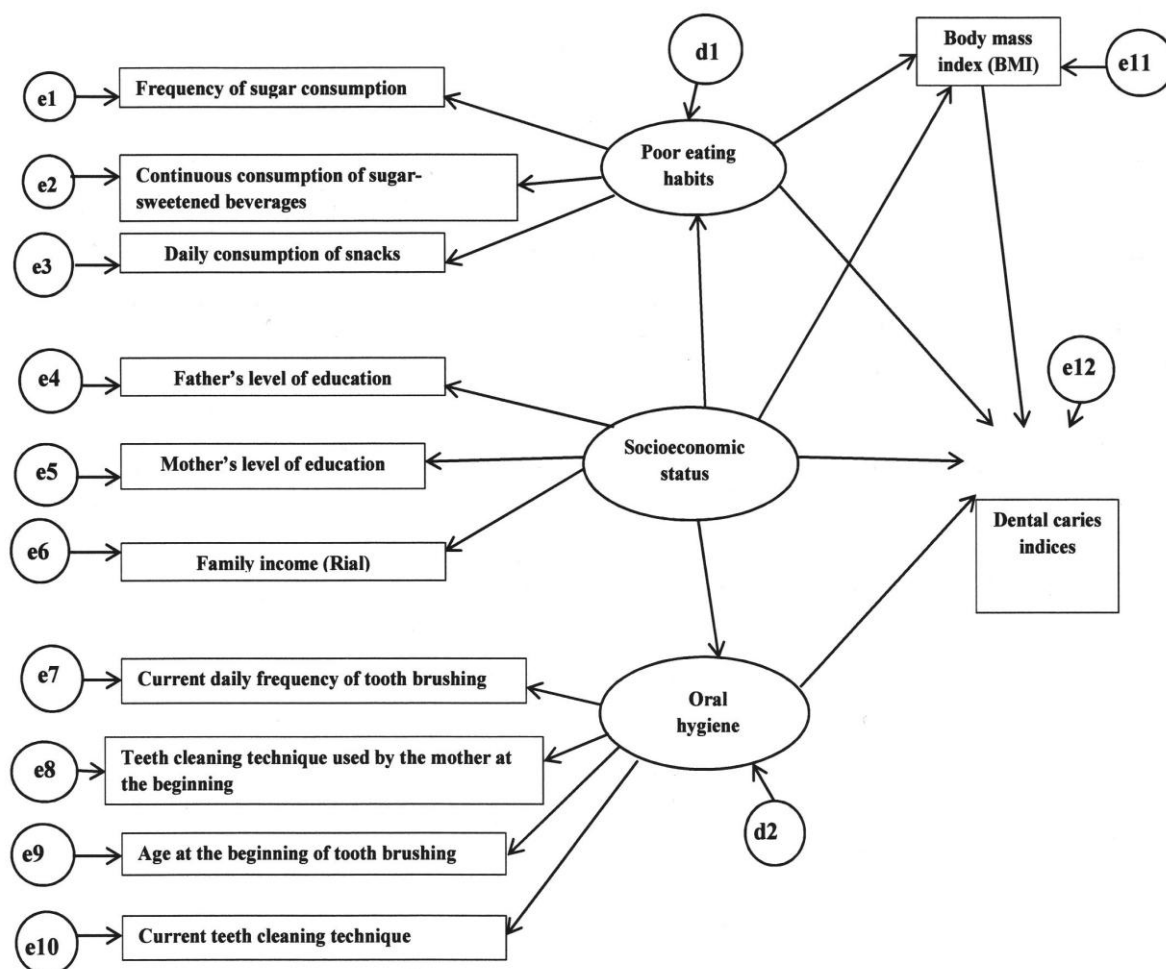


Figure 1. A hypothetical model of the associations between various risk factors and dental caries indices

Table 1. Baseline characteristics of the children and their parents (N=603)

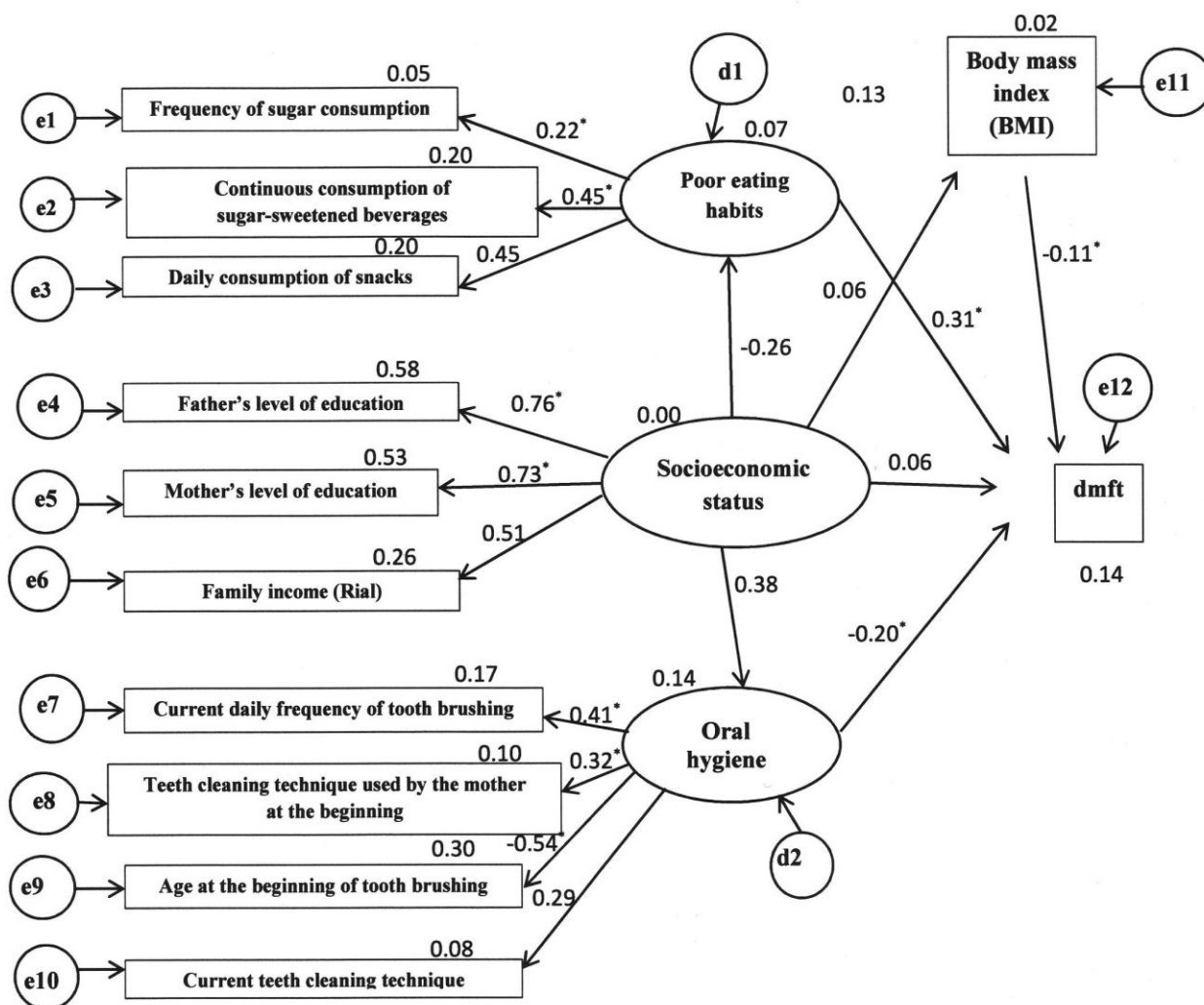
Variable	Frequency	Percentage
Gender		
Boy	350	58
Girl	253	42
Age (years)		
3	98	16.3
4	214	35.5
5	291	48.3
Head circumference (cm)		
Less than 50	162	26.9
50.5 to 52.5	315	52.2
More than 53	126	20.9
Body mass index (BMI)		
Under weight	139	23.1
Normal weight	390	64.7
Over weight	48	8.0
Obese	26	4.3
Father's level of education		
Illiterate, under diploma, diploma	209	34.7
Bachelor of sciences	265	43.9
Master of sciences and doctorate	129	21.4
Mother's level of education		
Illiterate, under diploma, diploma	171	28.4
Bachelor of sciences	337	55.9
Master of sciences and doctorate	95	15.8
Family income (Rial)		
Less than 10,000,000	219	36.3
More than 10,000,000	384	63.7
Continuous consumption of sugar-sweetened beverages		
No	340	56.4
Yes	263	43.6
Daily consumption of snacks		
No	359	59.5
Yes	244	40.5
Age at the beginning of tooth brushing (years)		
Less than 2	253	42.0
2 to 5	350	58.0
Teeth cleaning technique used by the mother at the beginning		
Washing	44	7.3
Brushing	487	80.8
Both	72	11.9
Current daily frequency of tooth brushing		
Sometimes	31	5.1
Once a day	495	82.1
Twice a day	77	12.8
Current teeth cleaning technique		
Brushing	329	54.6
Brushing and additional techniques	274	45.4
Frequency of sugar consumption		
Once or twice per week	398	66.0
More than twice per week	192	31.8
Everyday	13	2.2

Table 2. Descriptive statistics of the dmft and dmfs indices (N=603)

Variable	Minimum	Maximum	Mean	Standard Deviation
dmft*	0	20	6.45	4.02
dmfs**	0	68	11.62	10.61

*decayed-missing-filled-teeth

**decayed-missing-filled-surfaces

**Figure 2.** Standardized estimates of the structural equation modeling (SEM) for the decayed-missing-filled-teeth (dmft) index in the children aged 3-5 years

The model's goodness-of-fit indices: GFI=0.97, Adjusted Goodness-of-Fit Index (AGFI)=0.96, Comparative Fit Index (CFI)=0.94, $\frac{\chi^2}{df(\text{degrees of freedom})} = 1.75$, Root Mean Square Error of Approximation (RMSEA)=0.03

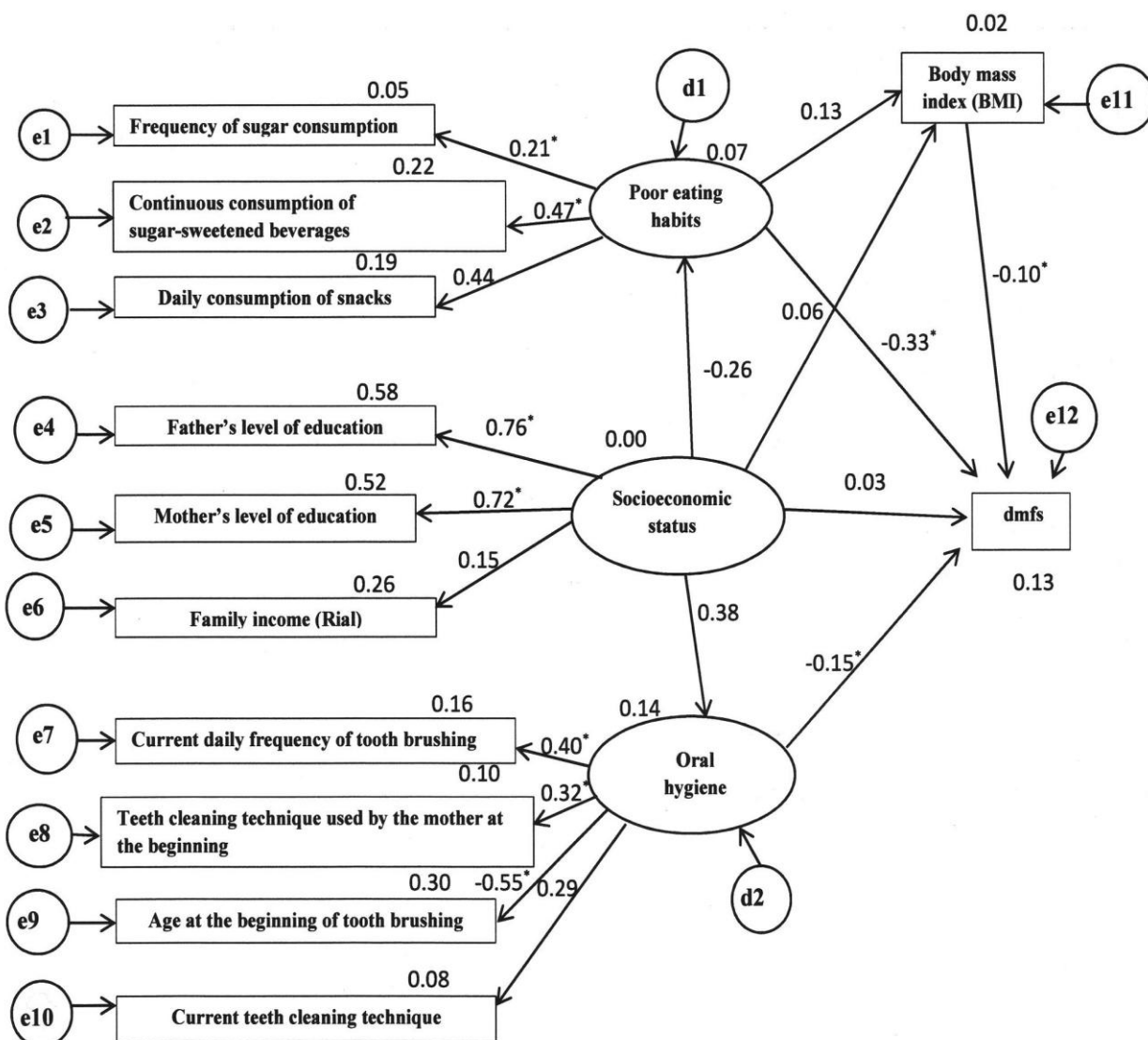


Figure 3. Standardized estimates of the structural equation modeling (SEM) for the decayed-missing-filled-surfaces (dmfs) index in the children aged 3-5 years

The model's goodness-of-fit indices: GFI=0.97, Adjusted Goodness-of-Fit Index (AGFI)=0.96, Comparative Fit Index (CFI)=0.94, $\frac{\chi^2}{df(\text{degrees of freedom})} = 1.75$, Root Mean Square Error of Approximation (RMSEA)=0.03

Table 3. Standardized effects of the variables on the dmft index in the children aged 3-5 years.
P-values are shown in parentheses

Latent variable	Direct effect	Indirect effect	Overall effect
Body mass index (BMI)	-0.11 (0.01)	---	-0.11 (0.01)
Poor eating habits	0.31 (<0.001)	-0.01(0.06)	0.30 (<0.001)
Household socioeconomic status	0.06 (0.29)	-0.15 (<0.001)	-0.09 (0.04)
Oral hygiene	-0.20 (0.01)	---	-0.20 (0.01)

Table 4. Standardized effects of the variables on the dmfs index in the children aged 3-5 years.
P-values are shown in parentheses

Latent variable	Direct effect	Indirect effect	Overall effect
Body mass index (BMI)	-0.10 (0.01)	---	-0.10 (0.01)
Poor eating habits	0.33 (<0.001)	-0.01 (0.06)	0.32 (<0.001)
Household socioeconomic status	0.03 (0.60)	-0.14 (<0.001)	-0.11 (0.02)
Oral hygiene	-0.15 (0.04)	---	-0.15 (0.04)

followed by oral hygiene, with a coefficient of -0.20 in the first model (Figure 2) and -0.15 in the second model (Figure 3), BMI, with a coefficient of -0.11 in the first model (Figure 2) and -0.10 in the second model (Figure 3), and the household socioeconomic status of family, with a coefficient of 0.06 in the first model (Figure 2) and 0.03 in the second model (Figure 3).

Discussion

The results of the current study showed that poor eating habits and oral hygiene had the greatest impact on the carious lesions in deciduous teeth. BMI and the socioeconomic status of family showed a significant correlation with dental caries in children.

A systematic review of the literature showed that dietary habits and oral hygiene were among the most important causes of tooth decay in children [24]. Also, similar to our findings, Marshall et al [25] found that consumption of industrial foods by children would increase the risk of tooth decay. Different studies have shown variable results with regards to the relationship between tooth decay and obesity [26-28], and the evidence to support a direct correlation between BMI and tooth decay is limited.

Contrary to these results, one study showed a significant direct correlation between weight gain and tooth decay [29]. Another study also confirmed this finding in infants [30]. Different methodologies could be a possible reason for the difference between the findings. Werner et al [28] also reported a similar relationship between BMI and dental caries. Previous studies suggest that the low socioeconomic status of family is one of the factors influencing the pathogenesis of dental caries [12,13,15,31]. The SEM approach distinguishes this work from similar studies. Our findings regarding the indirect effect of the socioeconomic status on dental caries are similar to the results of other related studies [32,33]. The socioeconomic status affects dental caries by means of sub-reasons such as diet and access to health services and facilities [34]. However, the direct effect of the socioeconomic status on dental caries indices is negligible, which may be logical with regards to the fact that the socioeconomic indices mostly have a direct effect on the health [34].

This study has some strong and weak points. The methodology of the study was cross-sectional; therefore, the possibility of reverse causality between different variables and dental caries

indices should be considered. While an undesirable dental status in children may change their dietary habits, poor eating habits may also lead to dental problems. Similar to any other research related to the household income evaluation, there were problems such as under- or over-reporting of the household income, recall bias, and reluctance to respond. Therefore, efforts were made to moderate these errors by shortening the recall period. Furthermore, we tried to resolve this problem by measuring other socioeconomic indicators such as parental education. The children who participated in the present study were selected from among the kindergartens of Tehran and may not be representative of all the children in this city with regards to all the evaluated fields. To resolve this problem, sampling was done in different geographical regions of Tehran to include various socioeconomic classes in the study.

Despite these limitations, to the best of our knowledge, this is the first study to investigate the causes of tooth decay in children by using the SEM approach. The adequate sample size and proper sampling methods are among the other advantages of this study.

Conclusion

Based on these results, it can be concluded that the most powerful factors which influence dental caries are the behavioral factors associated with nutrition and diet. These factors can be modified by applying public health strategies such as providing counseling and education on oral health behaviors and proper dietary habits for parents and children. Considering the importance of the socioeconomic factors, the interventions should be performed with an emphasis on the families with a low socioeconomic status.

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